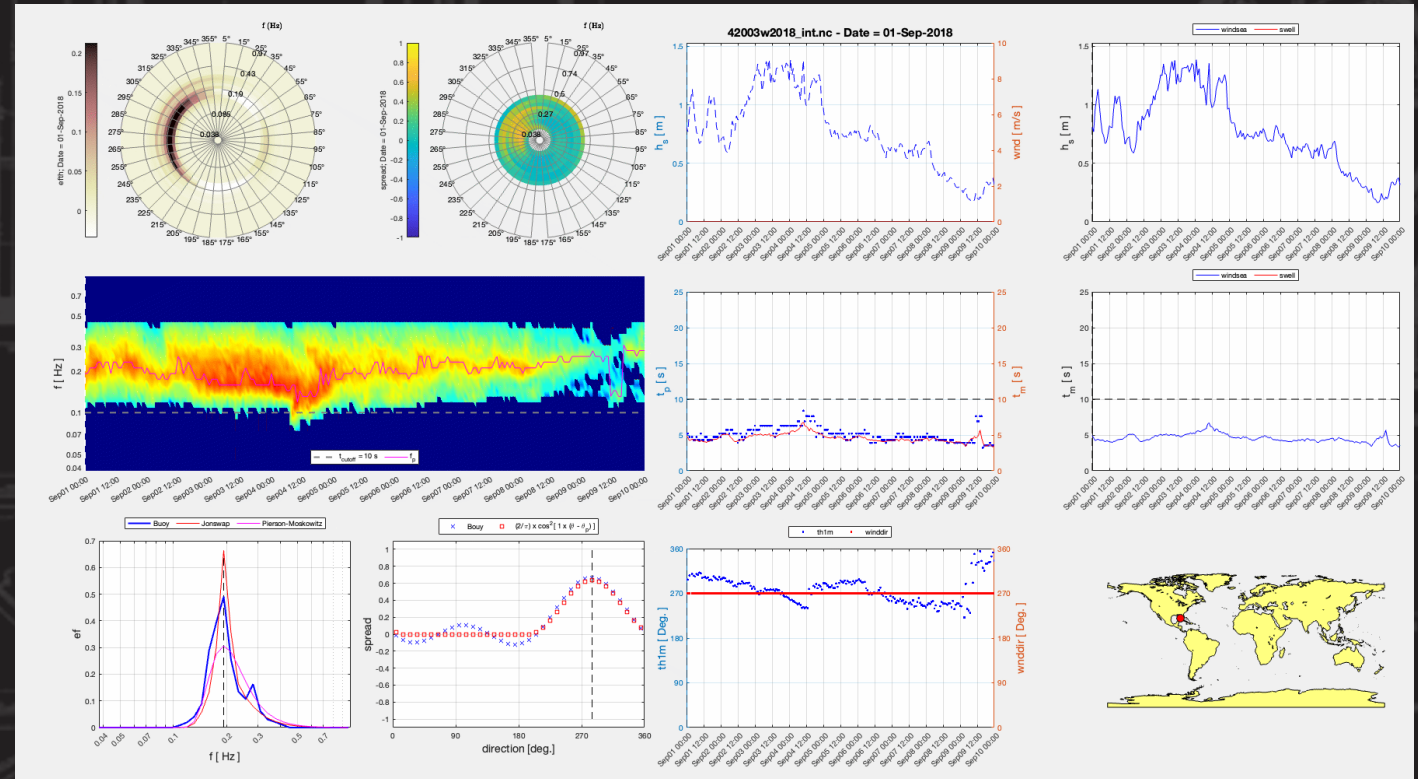


LECTURE 07: BOUNDARY CONDITIONS

Lecturer: Ali Abdolali, PhD.

ERDC Wind Waves Training



U.S. ARMY



US Army Corps
of Engineers®



WW3 VS OBS

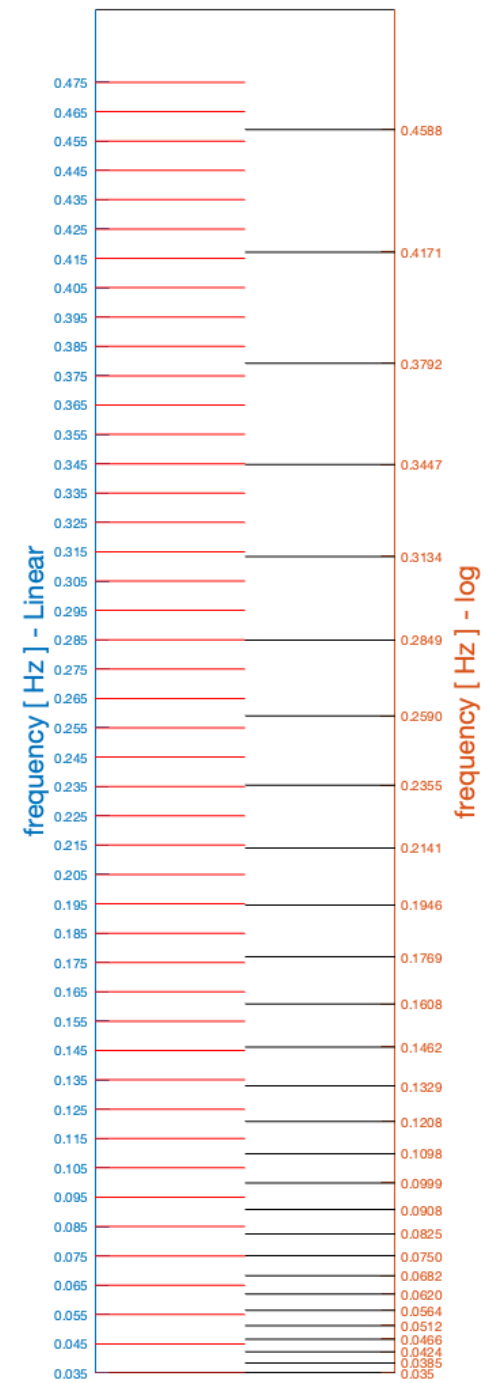
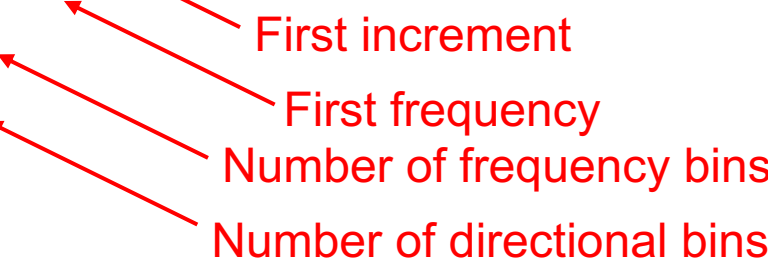
WW3 spectral discretization is in log scale, while most obs are provided with equal increment

The spectral resolution in WW3 is defined in ww3_grid.nml(inp)

```

! ----- !
! Define the spectrum parameterization via SPECTRUM_NML
namelist
! ----- !
&SPECTRUM_NML
  SPECTRUM%XFR           = 1.1
  SPECTRUM%FREQ1        = 0.035
  SPECTRUM%NK           = 35
  SPECTRUM%NTH          = 36
/

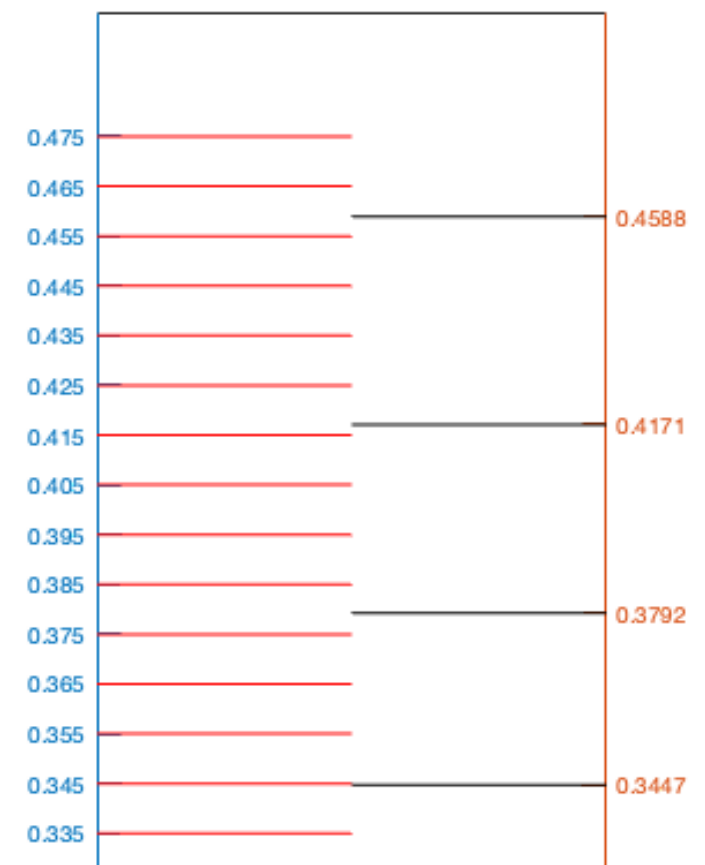
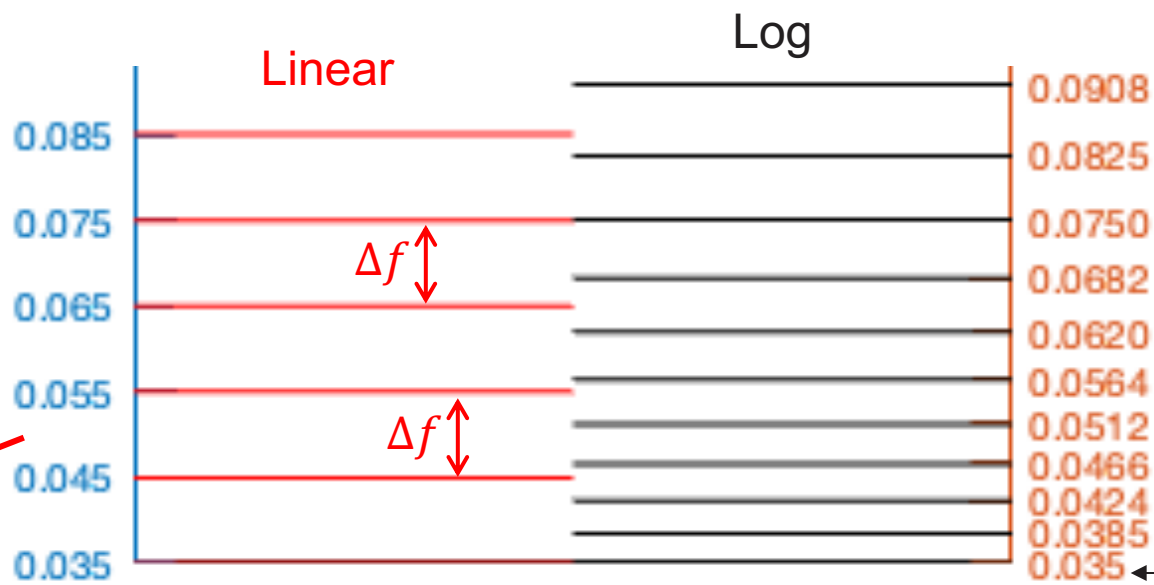
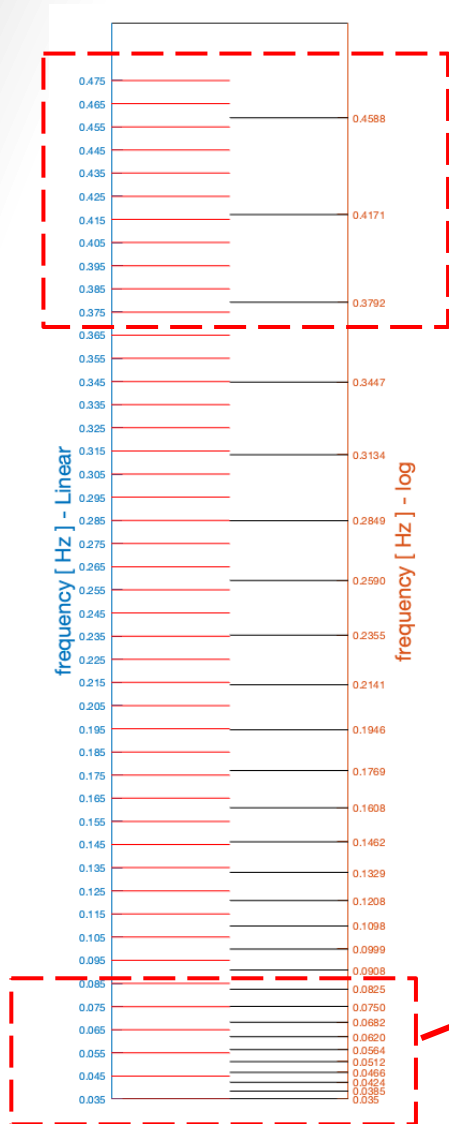
```



The recommended frequency increments are 1.07 and 1.1



WW3 VS OBS



$Inc^3 \cdot f_0$
 $Inc^2 \cdot f_0$
 $Inc \cdot f_0$
 First frequency (f_0)



HOW TO PROVIDE BOUNDARY CONDITIONS:

1- From a larger scale model:

In this case, the spectral resolution of the spectrum from larger scale simulation should match the local scale one, defined in `ww3_grid.nml(inp)`. If not, you can interpolate them.

2- From observations:

- The full spectrum from observations such as NDBC can be used, however, it should be interpolated to match the model spectral resolution.
- The bulk stats (significant wave height, peak period and mean wave direction) from observations and Jonswap or Pietson Moskowitz assumption can be used to generate synthetic boundary conditions.

What format:

WW3 has two programs that pre-process ascii and netcdf formats:

- `ww3_bounc`: netcdf
- `ww3_bound`: ascii



WW3_BOUNC: PROCESS NETCDF FILES

```

! ----- !
! WAVEWATCH III - ww3_bounc.nml - Boundary input post-processing      !
! ----- !
! ----- !
! Define the input boundaries to preprocess via BOUNC_NML namelist
!
! * namelist must be terminated with /
! * definitions & defaults:
!   BOUND%MODE           = 'WRITE'           ! ['WRITE'|'READ']
!   BOUND%INTERP         = 2                 ! interpolation [1(nearest),2(linear)]
!   BOUND%VERBOSE        = 1                 ! [0|1|2]
!   BOUND%FILE           = 'spec.list'       ! input _spec.nc listing file
! ----- !
&BOUNC_NML
/
! ----- !
! WAVEWATCH III - end of namelist
! ----- !

```

If you have more than one spec files, listed in spec.list, you can define either linear or nearest point for interpolation.



WW3 SPEC FILE (NETCDF)

Navigate to *boundary_condtion/bounc*
and use `ncdisp('bound.nc')` command in
`matlab` or `ncdump -h bound.nc` in terminal:

Dimensions:
time = 25 (UNLIMITED)
station = 1
string16 = 16
frequency = 32
direction = 36

Variables:

time
Size: 25x1
Dimensions: time
Datatype: double
Attributes:
long_name = 'julian day (UT)'
standard_name = 'time'
units = 'days since 1990-01-01 00:00:00'
conventions = 'Relative julian days with decimal part (as parts of the day)'
axis = 'T'

station

Size: 1x1
Dimensions: station
Datatype: int32
Attributes:
long_name = 'station id'
_FillValue = -2147483647
axis = 'X'

string16

Size: 16x1
Dimensions: string16
Datatype: int32
Attributes:
long_name = 'station_name number of characters'
_FillValue = -2147483647
axis = 'W'

station_name

Size: 16x1
Dimensions: string16,station
Datatype: char
Attributes:
long_name = 'station name'
content = 'XW'
associates = 'station string16'

longitude

Size: 1x25
Dimensions: station,time
Datatype: single
Attributes:
long_name = 'longitude'
standard_name = 'longitude'
globwave_name = 'longitude'
units = 'degree_east'
scale_factor = 1
add_offset = 0
valid_min = -180
valid_max = 360
_FillValue = 9.969209968386869e+36
content = 'TX'
associates = 'time station'

latitude

Size: 1x25
Dimensions: station,time
Datatype: single
Attributes:
long_name = 'latitude'
standard_name = 'latitude'
globwave_name = 'latitude'
units = 'degree_north'
scale_factor = 1
add_offset = 0
valid_min = -90
valid_max = 180
_FillValue = 9.969209968386869e+36
content = 'TX'
associates = 'time station'

frequency

Size: 32x1
Dimensions: frequency
Datatype: single
Attributes:
long_name = 'frequency of center band'
standard_name = 'sea_surface_wave_frequency'
globwave_name = 'frequency'
units = 's-1'
scale_factor = 1
_FillValue = 9.969209968386869e+36
axis = 'Y'

direction

Size: 36x1
Dimensions: direction
Datatype: single
Attributes:
long_name = 'sea surface wave to direction'
standard_name = 'sea_surface_wave_to_direction'
globwave_name = 'direction'
units = 'degree'
scale_factor = 1
add_offset = 0
valid_min = 0
valid_max = 360
_FillValue = 9.969209968386869e+36
axis = 'Z'

efth

Size: 36x32x1x25
Dimensions: direction,frequency,station,time
Datatype: single
Attributes:

long_name = 'sea surface wave directional variance spectral density'
standard_name = 'sea_surface_wave_directional_variance_spectral_density'
globwave_name = 'directional_variance_spectral_density'
units = 'm2 s rad-1'
scale_factor = 1
add_offset = 0
valid_min = 0
valid_max = 1.000000020040877e+20
_FillValue = 9.969209968386869e+36
content = 'TXYZ'
associates = 'time station frequency direction'

dpt

Size: 1x25
Dimensions: station,time
Datatype: single
Attributes:
long_name = 'depth'
standard_name = 'depth'
globwave_name = 'depth'
valid_min = -100
valid_max = 10000
_FillValue = 9.969209968386869e+36
associates = 'time station'



wnd

```

Size: 1x25
Dimensions: station,time
Datatype: single
Attributes:
    long_name = 'wind speed at 10m'
    standard_name = 'wind_speed'
    globwave_name = 'wind_speed'
    units = 'm s-1'
    scale_factor = 1
    add_offset = 0
    valid_min = 0
    valid_max = 100
    _FillValue = 9.969209968386869e+36
    content = 'TX'
    associates = 'time station'

```

wnddir

```

Size: 1x25
Dimensions: station,time
Datatype: single
Attributes:
    long_name = 'wind direction'
    standard_name = 'wind_from_direction'
    globwave_name = 'wind_from_direction'
    units = 'degree'
    scale_factor = 1
    add_offset = 0
    valid_min = 0
    valid_max = 360
    _FillValue = 9.969209968386869e+36
    content = 'TX'
    associates = 'time station'

```

cur

```

Size: 1x25
Dimensions: station,time
Datatype: single
Attributes:
    long_name = 'sea water speed'
    standard_name = 'sea_water_speed'
    globwave_name = 'sea_water_speed'
    units = 'm s-1'
    scale_factor = 1
    add_offset = 0
    valid_min = 0
    valid_max = 100
    _FillValue = 9.969209968386869e+36
    content = 'TX'
    associates = 'time station'

```

curdir

```

Size: 1x25
Dimensions: station,time
Datatype: single
Attributes:
    long_name = 'direction from of sea water

```

velocity'

```

    standard_name = 'direction_of_sea_water_velocity'
    globwave_name =
'direction_of_sea_water_velocity'
    units = 'degree'
    scale_factor = 1
    add_offset = 0
    valid_min = 0
    valid_max = 360
    _FillValue = 9.969209968386869e+36
    content = 'TX'
    associates = 'time station'

```



WW3_BOUND: PROCESS ASCII FILES

```

!-----!
! WAVEWATCH III - ww3_bound.nml - Boundary input post-processing !
!-----!
!-----!
! Define the input boundaries to preprocess via BOUND_NML namelist !
!
! * namelist must be terminated with /
! * definitions & defaults:
!   BOUND%MODE           = 'WRITE'           ! ['WRITE'|'READ']
!   BOUND%INTERP         = 2                 ! interpolation [1(nearest),2(linear)]
!   BOUND%VERBOSE        = 1                 ! [0|1|2]
!   BOUND%FILE           = 'spec.list'      ! input _spec.spc listing file
!-----!
&BOUND_NML
/
!-----!
! WAVEWATCH III - end of namelist
!-----!

```

If you have more than one spec files, listed in spec.list, you can define either linear or nearest point for interpolation.



WW3 SPEC FILE (ASCII)

No. of freq

No. of dir

'WAVEWATCH III SPECTRA' 50 36 1 'spectral resolution for points'

```

0.350E-01 0.375E-01 0.401E-01 0.429E-01 0.459E-01 0.491E-01 0.525E-01 0.562E-01
0.601E-01 0.643E-01 0.689E-01 0.737E-01 0.788E-01 0.843E-01 0.902E-01 0.966E-01
0.103E+00 0.111E+00 0.118E+00 0.127E+00 0.135E+00 0.145E+00 0.155E+00 0.166E+00
0.178E+00 0.190E+00 0.203E+00 0.217E+00 0.233E+00 0.249E+00 0.266E+00 0.285E+00
0.305E+00 0.326E+00 0.349E+00 0.374E+00 0.400E+00 0.428E+00 0.458E+00 0.490E+00
0.524E+00 0.561E+00 0.600E+00 0.642E+00 0.687E+00 0.735E+00 0.787E+00 0.842E+00
0.901E+00 0.964E+00

```

Frequency (Hz)

```

0.148E+01 0.131E+01 0.113E+01 0.960E+00 0.785E+00 0.611E+00 0.436E+00
0.262E+00 0.873E-01 0.620E+01 0.602E+01 0.585E+01 0.567E+01 0.550E+01
0.532E+01 0.515E+01 0.497E+01 0.480E+01 0.463E+01 0.445E+01 0.428E+01
0.410E+01 0.393E+01 0.375E+01 0.358E+01 0.340E+01 0.323E+01 0.305E+01
0.288E+01 0.271E+01 0.253E+01 0.236E+01 0.218E+01 0.201E+01 0.183E+01
0.166E+01

```

Direction (radian)

20220915 000000

Date

'21178 ' 33.19 133.62 409.1 9.21 80.2 0.05 27.7

ID Lat Lon Depth wnd wnddir cur curdir

```

0.159E-17 0.198E-17 0.548E-16 0.353E-14 0.111E-13 0.107E-12 0.515E-12
0.683E-12 0.396E-11 0.160E-10 0.287E-10 0.266E-10 0.293E-10 0.295E-10
0.321E-10 0.334E-10 0.311E-10 0.110E-10 0.414E-11 0.145E-11 0.339E-12
0.614E-13 0.560E-13 0.196E-12 0.235E-12 0.252E-12 0.840E-13 0.595E-13
0.658E-13 0.152E-12 0.659E-12 0.316E-11 0.112E-10 0.213E-10 0.244E-10
0.350E-10 0.704E-10 0.142E-09 0.259E-09 0.421E-09 0.621E-09 0.779E-09
0.758E-09 0.651E-09 0.459E-09 0.239E-09 0.124E-09 0.669E-10 0.895E-09
0.638E-09 0.197E-17 0.282E-16 0.145E-14 0.174E-13 0.105E-11 0.240E-10
0.390E-09 0.301E-08 0.883E-08 0.125E-07 0.415E-07 0.126E-06 0.321E-06
0.374E-06 0.181E-06 0.112E-06 0.510E-07 0.167E-07 0.396E-08 0.137E-08
0.270E-09 0.739E-10 0.181E-10 0.105E-10 0.124E-10 0.166E-10 0.250E-10
0.359E-10 0.525E-10 0.762E-10 0.111E-09 0.166E-09 0.277E-09 0.531E-09
. . .

```

SPEC



BUOY DATA

<https://www.ndbc.noaa.gov/>

National Data Buoy Center
NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION

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Station ID Search Go [Station List](#)

Recent Data Historical Data Show Labels [Link to This Map](#)

Program Filter:

NDBC Meteorological/Ocean
 International Partners
 IOOS Partners

Owner Filter:

NDBC
 Alaska Ocean Observing System
 APL-UW, University of Washington Applied Physics Laboratory

Oceans Select Region

2000 km
2000 mi

Esri, GEBCO, Garmin | Esri, GEBCO, NGS Powered by Esri

Stations with recent data 1222 stations displayed

<https://dods.ndbc.noaa.gov/>

Access the [NDBC and Partners Data](#)

The data are in subdirectories by type, then by station within each type. The data types are listed below. Both historical and "real-time" data are available in collections in the station folders. The collections are in separate files for each year of historical data, plus a file for the latest "real-time" data. The file naming convention is **SSSSStYYYY.nc**, where **SSSSS** will be the station's ID, **t** will be the data type, **YYYY** will be the year of the historical data or 9999 for the latest "real-time" data, and **.nc** indicates it is a netCDF file. The "real-time" data have not undergone NDBC's final archival quality processing. The term "real-time" is used to be consistent with the labels used on NDBC's main web site. The "real-time" files will contain up to 45 days of the latest data, to provide a continuous time series when coupled with the current year's historical data. Upon each month's final monthly archival quality processing, that month of historical data will be added to the current year file and removed from the 9999 file. There will be no overlaps.

The station folders are grouped under the following data type directories:

- [adcpr](#) - Acoustic Doppler Current Profiler data
- [adcpr2](#) - Acoustic Doppler Current Profiler data with additional QC information
- [cwind](#) - Continuous Winds data
- [dart](#) - Deep-ocean Assessment and Reporting of Tsunamis data
- [mmbcur](#) - Marsh-McBirney Current Measurements data
- [ocean](#) - Oceanographic data
- [pwind](#) - Peak Winds data
- [stdmet](#) - Standard Meteorological data
- [swden](#) - Spectral Wave Density data with Spectral Wave Direction data
- [wlevel](#) - Water Level data

Access the [NDBC TAO Buoy Data](#)

In addition, a special folder [oceansites](#) holds the top level directories for the Global Data Assembly Center (GDAC) of [OceanSITES](#). The data files are provided by the member institutions of OceanSITES and are organized under site subdirectories. They follow the OceanSITES format specifications in addition to the NetCDF CF Metadata Conventions. In particular, the [NDBC TAO Buoy Data](#) in the GDAC are the NDBC's contributions to OceanSITES. For more information visit [OceanSITES Project Office](#).



BUOY DATA

α_1 : mean wave direction

α_2 : principle wave direction

R_1, R_2 : parameters which describe the directional spreading about the main direction. These two parameters are the first and second normalized polar coordinates of the Fourier coefficients and are nondimensional.

θ : Azimuth angle measured clockwise from true North to the direction wave is from.

$D(\theta, f) = \frac{1}{\pi} [0.5 + R_1 \cos(\theta - \alpha_1)] + R_2 \cos(2(\theta - \alpha_2))$: Direction Spread

$E(\theta, f) = S(f)D(\theta, f)$: Directional Spectral Energy

$D(\theta, f)$ can take on negative values because of the trigonometric sine and cosine functions. There are several approaches to prevent or deal with the negative values. For more information and discussion of some approaches see: Use of advanced directional wave spectra analysis methods, M. D. Earle, K. E. Steele, and D. W. C. Wang, Ocean Engineering, Volume 26, Issue 12, December 1999, Pages 1421-1434.



NDBC - FULL SPEC (NETCDF)

Navigate to *boundary_condtion/bounc* and use `ncdisp('42003w2018.nc')` command in matlab or `ncdump -h 42003w2018.nc` in terminal

```

Dimensions:
  time      = 7341 (UNLIMITED)
  frequency = 47
  latitude  = 1
  longitude = 1
Variables:
  time
    Size:      7341x1
    Dimensions: time
    Datatype:  int32
    Attributes:
      long_name = 'Epoch Time'
      short_name = 'time'
      standard_name = 'time'
      units = 'seconds since 1970-01-01 00:00:00 UTC'

  frequency
    Size:      47x1
    Dimensions: frequency
    Datatype:  single
    Attributes:
      long_name = 'Frequency'
      short_name = 'frequency'
      standard_name = 'frequency'
      units = 'Hz'

  latitude
    Size:      1x1
    Dimensions: latitude
    Datatype:  single
    Attributes:
      long_name = 'Latitude'
      short_name = 'latitude'
      standard_name = 'latitude'
      units = 'degrees_north'

  longitude
    Size:      1x1
    Dimensions: longitude
    Datatype:  single
    Attributes:
      long_name = 'Longitude'
      short_name = 'longitude'
      standard_name = 'longitude'
      units = 'degrees_east'

```

```

spectral_wave_density
  Size:      1x1x47x7341
  Dimensions: longitude,latitude,frequency,time
  Datatype:  single
  Attributes:
    long_name = 'Spectral Wave Density'
    short_name = 'swden'
    standard_name = 'spectral_wave_density'
    units = '(meter * meter)/Hz'
    _FillValue = 999

mean_wave_dir
  Size:      1x1x47x7341
  Dimensions: longitude,latitude,frequency,time
  Datatype:  int32
  Attributes:
    long_name = 'Mean Wave Direction'
    short_name = 'alpha1'
    standard_name = 'mean_wave_direction'
    units = 'degrees_true'
    _FillValue = 999

principal_wave_dir
  Size:      1x1x47x7341
  Dimensions: longitude,latitude,frequency,time
  Datatype:  int32
  Attributes:
    long_name = 'Principal Wave Direction'
    short_name = 'alpha2'
    standard_name = 'principal_wave_direction'
    units = 'degrees_true'
    _FillValue = 999

wave_spectrum_r1
  Size:      1x1x47x7341
  Dimensions: longitude,latitude,frequency,time
  Datatype:  single
  Attributes:
    long_name = 'First Normalized Polar Coordinate Derived from the Fourier Coefficients'
    short_name = 'r1'
    standard_name = 'wave_spectrum_r1'
    _FillValue = 999

wave_spectrum_r2
  Size:      1x1x47x7341
  Dimensions: longitude,latitude,frequency,time
  Datatype:  single
  Attributes:
    long_name = 'Second Normalized Polar Coordinate Derived from the Fourier Coefficients'
    short_name = 'r2'
    standard_name = 'wave_spectrum_r2'
    _FillValue = 999


```



NDBC - FULL SPEC (ASCII)

https://www.ndbc.noaa.gov/station_history.php?station=42003

← → ↻ ndbc.noaa.gov/station_history.php?station=42003

 **NATIONAL DATA BUOY CENTER**
NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION

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Station 42003 (LLNR 1460) - East GULF - 208 NM West of Naples, FL

Owned and maintained by National Data Buoy Center
25.925 N 85.616 W (25°55'31" N 85°36'58" W)

Available historical data for station 42003 include:

- [Historical data](#) (*data descriptions*)
 - **Standard meteorological data:** [1976](#) [1977](#) [1978](#) [1979](#) [1980](#) [1981](#) [1982](#) [1983](#) [1984](#) [1985](#) [1986](#) [1987](#) [1988](#) [1989](#) [1990](#) [1991](#) [1992](#) [1993](#) [1994](#) [1995](#) [1996](#) [1997](#) [1998](#) [1999](#) [2000](#) [2001](#) [2002](#) [2003](#) [2004](#) [2005](#) [2006](#) [2007](#) [2008](#) [2009](#) [2010](#) [2011](#) [2012](#) [2013](#) [2014](#) [2015](#) [2016](#) [2017](#) [2018](#) [2019](#) [2020](#) [2021](#) [2022](#)
 - **Continuous winds data:** [1989](#) [1990](#) [1991](#) [1992](#) [1993](#) [1996](#) [1997](#) [1998](#) [1999](#) [2000](#) [2001](#) [2002](#) [2003](#) [2004](#) [2005](#) [2006](#) [2007](#) [2008](#) [2009](#) [2010](#) [2011](#) [2012](#) [2013](#) [2014](#) [2015](#) [2016](#) [2017](#)
 - **Spectral wave density data:** [1996](#) [1997](#) [1998](#) [1999](#) [2000](#) [2001](#) [2002](#) [2003](#) [2004](#) [2005](#) [2006](#) [2007](#) [2008](#) [2009](#) [2010](#) [2011](#) [2012](#) [2013](#) [2014](#) [2015](#) [2016](#) [2017](#) [2018](#) [2019](#) [2020](#) [2021](#) [2022](#)
 - **Spectral wave (alpha1) direction data:** [1996](#) [1997](#) [1998](#) [1999](#) [2000](#) [2001](#) [2002](#) [2003](#) [2004](#) [2005](#) [2006](#) [2007](#) [2008](#) [2009](#) [2010](#) [2011](#) [2012](#) [2013](#) [2014](#) [2015](#) [2016](#) [2017](#) [2018](#) [2019](#) [2020](#) [2021](#) [2022](#)
 - **Spectral wave (alpha2) direction data:** [1997](#) [1998](#) [1999](#) [2000](#) [2001](#) [2002](#) [2003](#) [2004](#) [2005](#) [2006](#) [2007](#) [2008](#) [2009](#) [2010](#) [2011](#) [2012](#) [2013](#) [2014](#) [2015](#) [2016](#) [2017](#) [2018](#) [2019](#) [2020](#) [2021](#) [2022](#)
 - **Spectral wave (r1) direction data:** [1997](#) [1998](#) [1999](#) [2000](#) [2001](#) [2002](#) [2003](#) [2004](#) [2005](#) [2006](#) [2007](#) [2008](#) [2009](#) [2010](#) [2011](#) [2012](#) [2013](#) [2014](#) [2015](#) [2016](#) [2017](#) [2018](#) [2019](#) [2020](#) [2021](#) [2022](#)
 - **Spectral wave (r2) direction data:** [1997](#) [1998](#) [1999](#) [2000](#) [2001](#) [2002](#) [2003](#) [2004](#) [2005](#) [2006](#) [2007](#) [2008](#) [2009](#) [2010](#) [2011](#) [2012](#) [2013](#) [2014](#) [2015](#) [2016](#) [2017](#) [2018](#) [2019](#) [2020](#) [2021](#) [2022](#)
 - **Supplemental measurements data:** [2010](#) [2011](#) [2012](#) [2013](#) [2014](#) [2017](#) [2018](#) [2019](#) [2020](#) [2021](#) [2022](#)
- [Search historical meteorological data for observations that meet your threshold conditions](#)
- Climatic summary [table](#) (TXT) and plots of (*description of tables and plots*)
 - [wind speed](#)
 - [air temperature](#)
 - [sea temperature](#)
 - [air-sea temperature](#)
 - [dew point temperature](#)
 - [air-dew point temperature](#)
 - [sea level pressure](#)
 - [peak wind](#)
 - [wind gust](#)
 - [significant wave height](#)
 - [average wave period](#)
 - [dominant wave period](#)

Some data files have been compressed with the GNU gzip program.



NDBC – BULK STATISTICS (NETCDF)

Navigate to *boundary_condtion/bounc* and use `ncdisp('42003h2018.nc')` command in matlab or `ncdump -h 42003h2018.nc` in terminal

```

Dimensions:
  time = 44373 (UNLIMITED)
  latitude = 1
  longitude = 1
Variables:
  time
    Size: 44373x1
    Dimensions: time
    Datatype: int32
    Attributes:
      long_name = 'Epoch Time'
      short_name = 'time'
      standard_name = 'time'
      units = 'seconds since 1970-01-01 00:00:00 UTC'

  latitude
    Size: 1x1
    Dimensions: latitude
    Datatype: single
    Attributes:
      long_name = 'Latitude'
      short_name = 'latitude'
      standard_name = 'latitude'
      units = 'degrees_north'

  longitude
    Size: 1x1
    Dimensions: longitude
    Datatype: single
    Attributes:
      long_name = 'Longitude'
      short_name = 'longitude'
      standard_name = 'longitude'
      units = 'degrees_east'

  wind_dir
    Size: 1x1x44373
    Dimensions: longitude,latitude,time
    Datatype: int32
    Attributes:
      long_name = 'Wind Direction'
      short_name = 'wdir'
      standard_name = 'wind_from_direction'
      units = 'degrees_true'
      _FillValue = 999

  ...

```

```

wave_height
  Size: 1x1x44373
  Dimensions: longitude,latitude,time
  Datatype: single
  Attributes:
    long_name = 'Significant Wave Height'
    short_name = 'wwht'
    standard_name = 'significant_height_of_wave'
    units = 'meters'
    _FillValue = 99

  dominant_wpd
    Size: 1x1x44373
    Dimensions: longitude,latitude,time
    Datatype: single
    Attributes:
      long_name = 'Dominant Wave Period'
      short_name = 'dpd'
      standard_name = 'dominant_wave_period'
      units = 'seconds'
      _FillValue = 99

  average_wpd
    Size: 1x1x44373
    Dimensions: longitude,latitude,time
    Datatype: single
    Attributes:
      long_name = 'Average Wave Period'
      short_name = 'apd'
      standard_name = 'average_wave_period'
      units = 'seconds'
      _FillValue = 99

  mean_wave_dir
    Size: 1x1x44373
    Dimensions: longitude,latitude,time
    Datatype: int32
    Attributes:
      long_name = 'Mean Wave Direction'
      short_name = 'mwd'
      standard_name = 'mean_wave_direction'
      units = 'degrees_true'
      _FillValue = 999

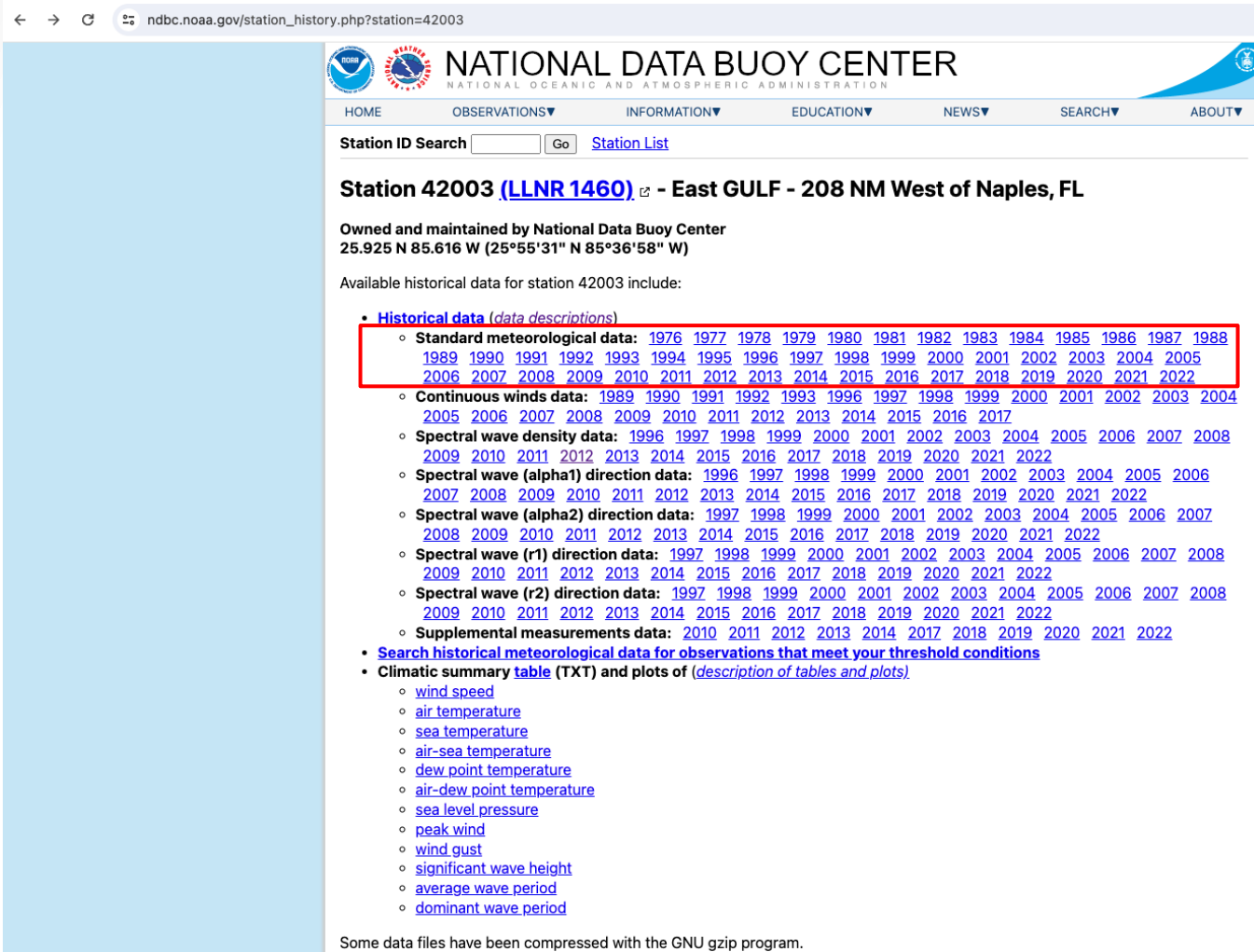
  water_level
    Size: 1x1x44373
    Dimensions: longitude,latitude,time
    Datatype: single
    Attributes:
      long_name = 'Tide Water Level'
      short_name = 'tide'
      standard_name = 'water_level'
      units = 'feet'
      _FillValue = 99

```



NDBC – BULK STATISTICS (ASCII)

https://www.ndbc.noaa.gov/station_history.php?station=42003



← → ↻ ndbc.noaa.gov/station_history.php?station=42003

NATIONAL DATA BUOY CENTER
NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION

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Station 42003 (LLNR 1460) - East GULF - 208 NM West of Naples, FL

Owned and maintained by National Data Buoy Center
25.925 N 85.616 W (25°55'31" N 85°36'58" W)

Available historical data for station 42003 include:

- **Historical data** ([data descriptions](#))
 - **Standard meteorological data:** [1976](#) [1977](#) [1978](#) [1979](#) [1980](#) [1981](#) [1982](#) [1983](#) [1984](#) [1985](#) [1986](#) [1987](#) [1988](#) [1989](#) [1990](#) [1991](#) [1992](#) [1993](#) [1994](#) [1995](#) [1996](#) [1997](#) [1998](#) [1999](#) [2000](#) [2001](#) [2002](#) [2003](#) [2004](#) [2005](#) [2006](#) [2007](#) [2008](#) [2009](#) [2010](#) [2011](#) [2012](#) [2013](#) [2014](#) [2015](#) [2016](#) [2017](#) [2018](#) [2019](#) [2020](#) [2021](#) [2022](#)
 - **Continuous winds data:** [1989](#) [1990](#) [1991](#) [1992](#) [1993](#) [1996](#) [1997](#) [1998](#) [1999](#) [2000](#) [2001](#) [2002](#) [2003](#) [2004](#) [2005](#) [2006](#) [2007](#) [2008](#) [2009](#) [2010](#) [2011](#) [2012](#) [2013](#) [2014](#) [2015](#) [2016](#) [2017](#)
 - **Spectral wave density data:** [1996](#) [1997](#) [1998](#) [1999](#) [2000](#) [2001](#) [2002](#) [2003](#) [2004](#) [2005](#) [2006](#) [2007](#) [2008](#) [2009](#) [2010](#) [2011](#) [2012](#) [2013](#) [2014](#) [2015](#) [2016](#) [2017](#) [2018](#) [2019](#) [2020](#) [2021](#) [2022](#)
 - **Spectral wave (alpha1) direction data:** [1996](#) [1997](#) [1998](#) [1999](#) [2000](#) [2001](#) [2002](#) [2003](#) [2004](#) [2005](#) [2006](#) [2007](#) [2008](#) [2009](#) [2010](#) [2011](#) [2012](#) [2013](#) [2014](#) [2015](#) [2016](#) [2017](#) [2018](#) [2019](#) [2020](#) [2021](#) [2022](#)
 - **Spectral wave (alpha2) direction data:** [1997](#) [1998](#) [1999](#) [2000](#) [2001](#) [2002](#) [2003](#) [2004](#) [2005](#) [2006](#) [2007](#) [2008](#) [2009](#) [2010](#) [2011](#) [2012](#) [2013](#) [2014](#) [2015](#) [2016](#) [2017](#) [2018](#) [2019](#) [2020](#) [2021](#) [2022](#)
 - **Spectral wave (r1) direction data:** [1997](#) [1998](#) [1999](#) [2000](#) [2001](#) [2002](#) [2003](#) [2004](#) [2005](#) [2006](#) [2007](#) [2008](#) [2009](#) [2010](#) [2011](#) [2012](#) [2013](#) [2014](#) [2015](#) [2016](#) [2017](#) [2018](#) [2019](#) [2020](#) [2021](#) [2022](#)
 - **Spectral wave (r2) direction data:** [1997](#) [1998](#) [1999](#) [2000](#) [2001](#) [2002](#) [2003](#) [2004](#) [2005](#) [2006](#) [2007](#) [2008](#) [2009](#) [2010](#) [2011](#) [2012](#) [2013](#) [2014](#) [2015](#) [2016](#) [2017](#) [2018](#) [2019](#) [2020](#) [2021](#) [2022](#)
 - **Supplemental measurements data:** [2010](#) [2011](#) [2012](#) [2013](#) [2014](#) [2017](#) [2018](#) [2019](#) [2020](#) [2021](#) [2022](#)
- **Search historical meteorological data for observations that meet your threshold conditions**
- Climatic summary [table](#) (TXT) and plots of ([description of tables and plots](#))
 - [wind speed](#)
 - [air temperature](#)
 - [sea temperature](#)
 - [air-sea temperature](#)
 - [dew point temperature](#)
 - [air-dew point temperature](#)
 - [sea level pressure](#)
 - [peak wind](#)
 - [wind gust](#)
 - [significant wave height](#)
 - [average wave period](#)
 - [dominant wave period](#)

Some data files have been compressed with the GNU gzip program.



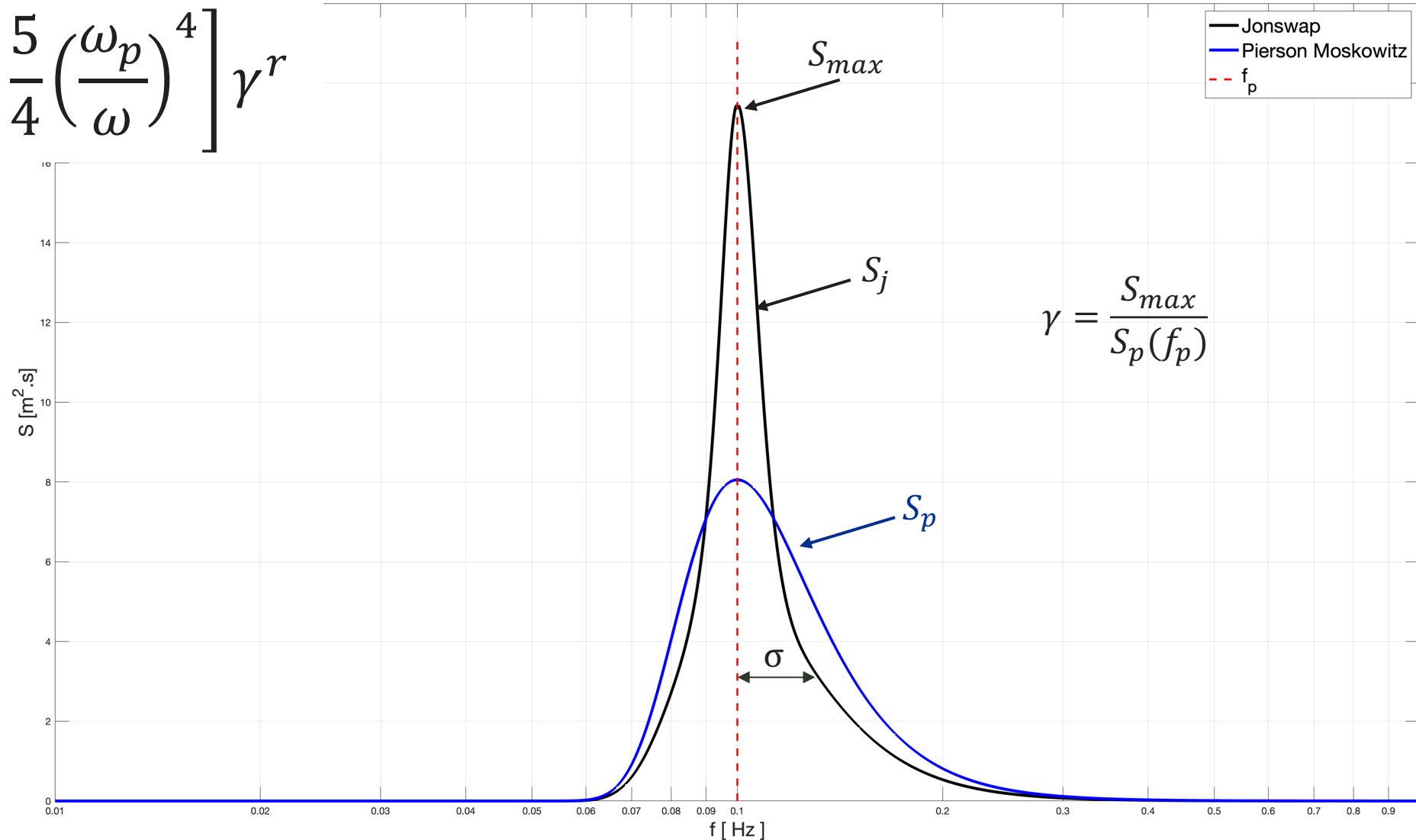
JONSWAP & PIERSON-MOSKOWITZ

$$S(\omega) = \frac{\alpha g^2}{\omega^5} \exp \left[-\frac{5}{4} \left(\frac{\omega_p}{\omega} \right)^4 \right] \gamma^r$$

$$r = \exp \left[-\frac{(\omega - \omega_p)^2}{2\sigma^2 \omega_p^2} \right]$$

$$\sigma = \begin{cases} 0.07 & \omega < \omega_p \\ 0.09 & \omega \geq \omega_p \end{cases}$$

$$\gamma = \begin{cases} 3.3 & \text{JONSWAP} \\ 1 & \text{Pierson Moskowitz} \end{cases}$$





INTERPOLATION

For ASCII format, there are scripts which read the ascii (either spec from WW3 or NDBC) and write them into netcdf format.

Then, interpolation scripts are used to match the spectral resolution (netcdf to netcdf).

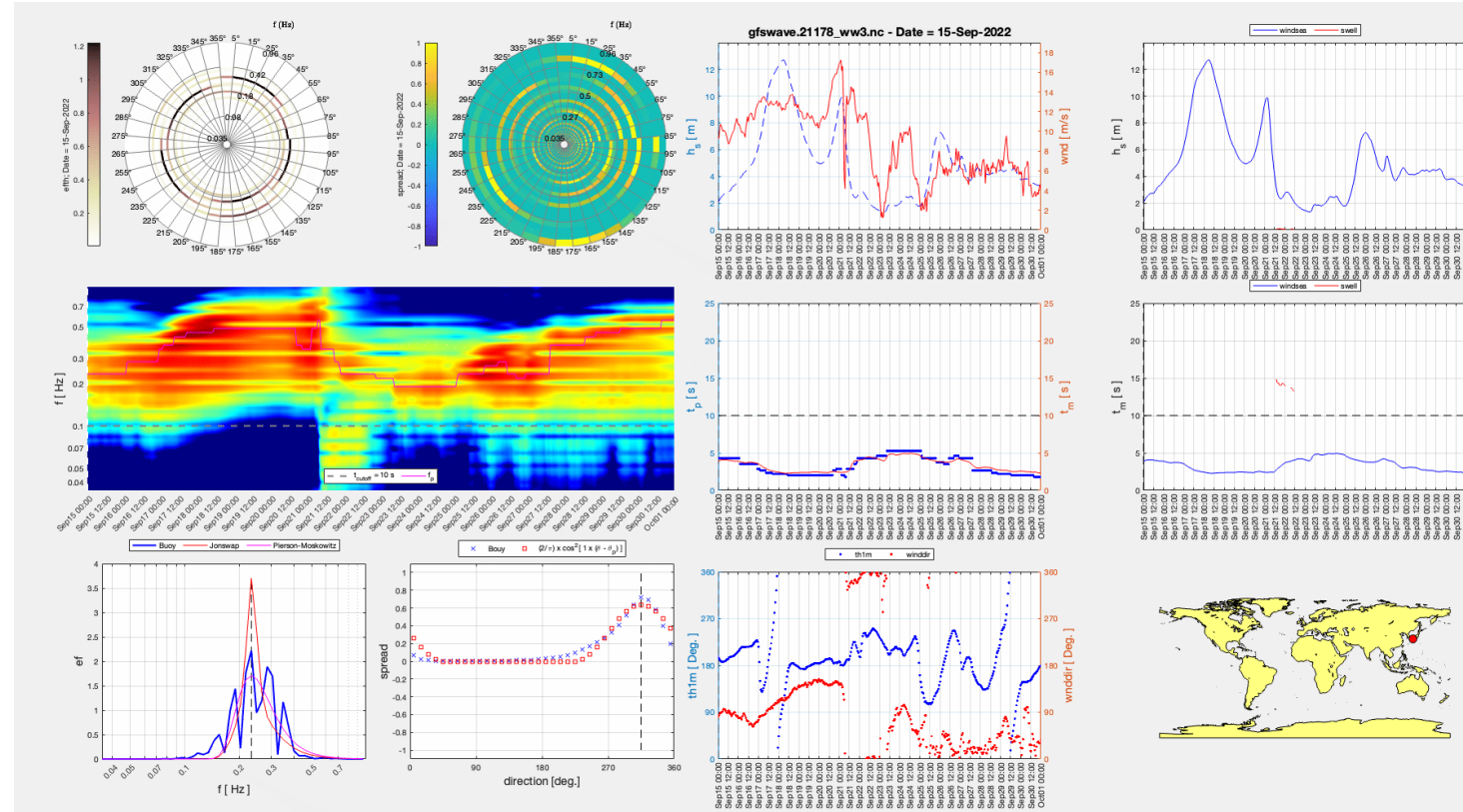
WW3 full spec (ASCII)

```
cd boundary_condition/bound
[IN] = swden_ww3_read_ascii('gfswave.21178.spec');
testcase='boundary'; % test case
coordinate='spherical'; % coordinate : Spherical, cartesian
filenameIN='gfswave.21178_ww3.nc'; % name of netcdf file (boundary)
[filename] = write_directional_spectra_nc(filenameIN, testcase, ...
IN.pointID, IN.lat, IN.lon, IN.dpt, IN.wnd, IN.wnddir, IN.cur, IN.curdir, ...
IN.time, IN.frequency, IN.direction, IN.efth, coordinate);
```



To visualize it, you can try the following:

```
input_nc='gfswave.21178_ww3.nc'  
ID=1  
START='20220915 000000'  
END='20221001 000000'  
factor=1  
dt=1/24  
dtplot=1/2  
visualize='true'
```



```
[SWDEN]= plot_ww3_spec(input_nc, ID, START, END, factor, dt, dtplot, visualize)
```



SPEC INTERPOLATION

To interpolate on a target spectral resolution:

```
nfreq=32; % number of frequencies
```

```
nDir=36; % number of Directions
```

```
inc=1.1; % frequency increment
```

```
f0=0.05;
```

```
filenameIN='gfswave.21178_ww3.nc'; % name of netcdf file
```

```
filenameOUT='bgfswave.21178_interp_ww3.nc'; % name of netcdf file
```

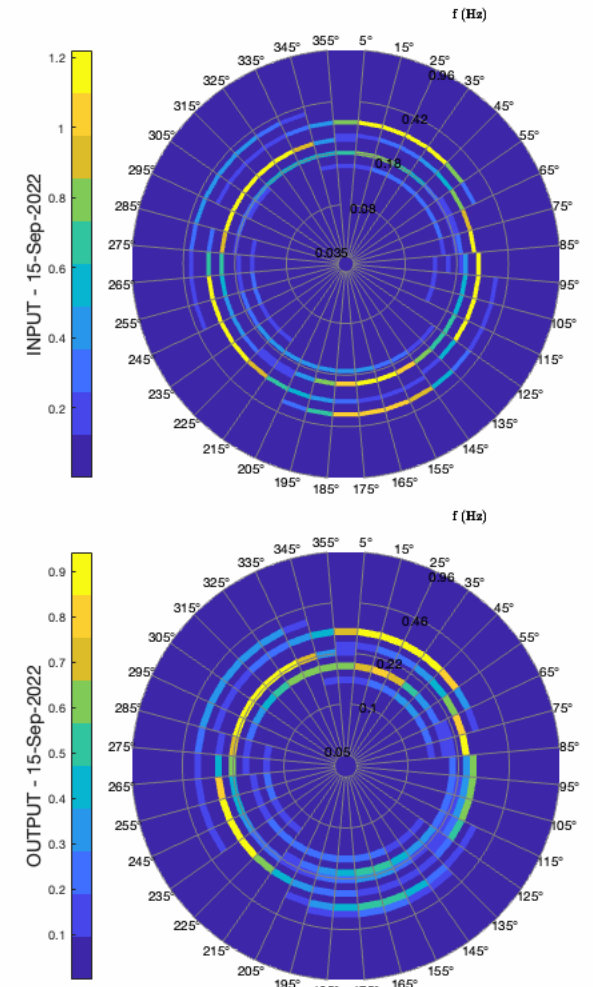
```
coordinate='spherical'; % coordinate : Spherical, cartesian
```

```
visualize='true';
```

```
deltatheta=360/nDir;
```

```
[IN,OUT]= spec_interp_nc(filenameIN,filenameOUT,nfreq,f0,inc,nDir,...
```

```
coordinate,visualize);
```





INTERPOLATION

NDBC full spec (NETCDF)

```
cd boundary_condition/bounc
nfreq=32; % number of frequencies
nDir=36; % number of Directions
inc=1.1; % frequency increment
f0=0.05;
deltatheta=360/nDir;
theta0=5;
freq=f0;
for i=1:nfreq-1
freq(end+1,1)=freq(end)*inc;
end
[SWDEN] = swden_ndbc_read('42003w2018.nc',deltatheta,theta0,freq);
```



ADD REQUIRED VARIABLES

```

%% input data %%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
nfreq=35;                % number of frequencies
nDir=36;                 % number of Directions
Dir0=5;                  % first direction (deg)
inc=1.1;                 % frequency increment
f0=0.038;
filename='42003w2018_int.nc';% name of netcdf file (boundary)
testcase='42003';        % test vase
pointID='42003';         % id (length should be 16)
Lat=25.925;              % latitude of BC (deg)
Lon=-85.616;             % longitude of BC (deg)
dpt=3273;                % Depth of BC (m)
wndspd=0;                % wind speed (m/s)
wnddir=270;              % wind direction (deg)
curspd=0;                % current velocity (m/s)
curdir=270;              % current direction (deg)
coordinate='spherical';  % coordinate : Spherical, cartesian
ncf='42003w2018.nc';    % input netcdf file from https://dods.ndbc.noaa.gov/
visualize='true';        % options:true, false- this requires polarPcolor function and can be obtained from ...
                          % https://www.mathworks.com/matlabcentral/fileexchange/49040-pcolor-in-polar-coordinates

deltatheta=360/nDir;     % DeltaDir
theta0=5;                % first Dir
%-----%
%-----%
% frequency (log)
Omega(1)=2*pi*f0;
for i=2:nfreq
Omega(i)=inc*Omega(i-1);
end
freq=Omega/2/pi;

```



ADD REQUIRED VARIABLES

```

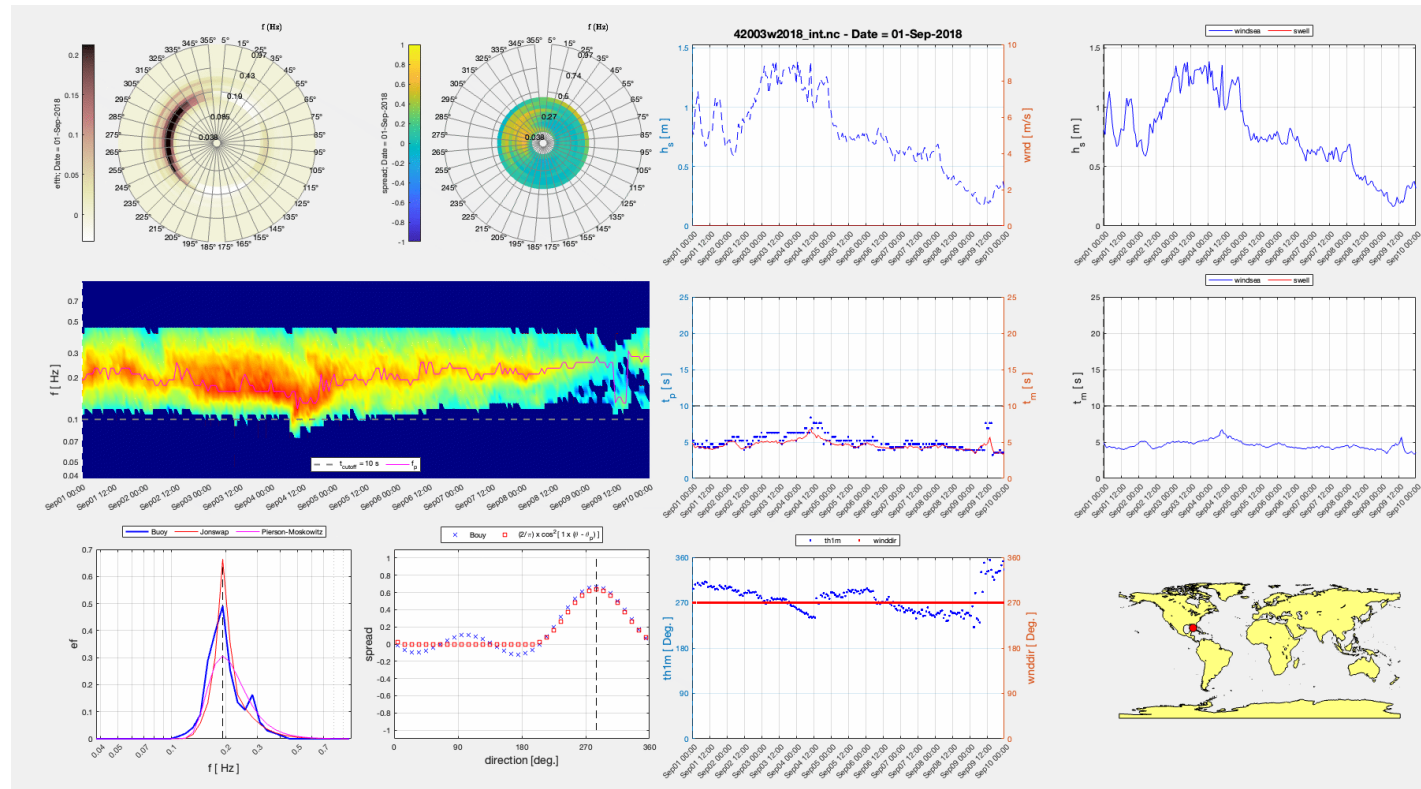
pointID = [pointID, repmat(' ', [1, 16-strlength(pointID)])];
Lon=Lon*ones(1, length(SWDEN.Int.time));
Lat=Lat*ones(1, length(SWDEN.Int.time));
curspd=curspd*ones(1, length(SWDEN.Int.time));
curdir=curdir*ones(1, length(SWDEN.Int.time));
wndspd=wndspd*ones(1, length(SWDEN.Int.time));
wnddir=wnddir*ones(1, length(SWDEN.Int.time));
dpt=dpt*ones(1, length(SWDEN.Int.time));
time(1,:) = SWDEN.Int.time;
dir=pi*SWDEN.Int.Dir/180; %radian
dir0=SWDEN.Int.Dir;%degree
EFTH(:, :, 1, :) = SWDEN.Int.DENS; %directional spectral density time series
%-----%
display(['Generating ', filename, ' ...'])
%dump into netcdf
[filename] = write_directional_spectra_nc(filename, testcase, ...
pointID, Lat, Lon, dpt, wndspd, wnddir, curspd, curdir, time, ...
SWDEN.Int.f, dir0, EFTH, coordinate);

```



To visualize it, you can try the following:

```
input_nc= '42003w2018_int.nc';
ID=1
START= '20180901 000000'
END= '20180910 000000'
factor=1
dt=1/24
dtplot=1/2
visualize='true'
```



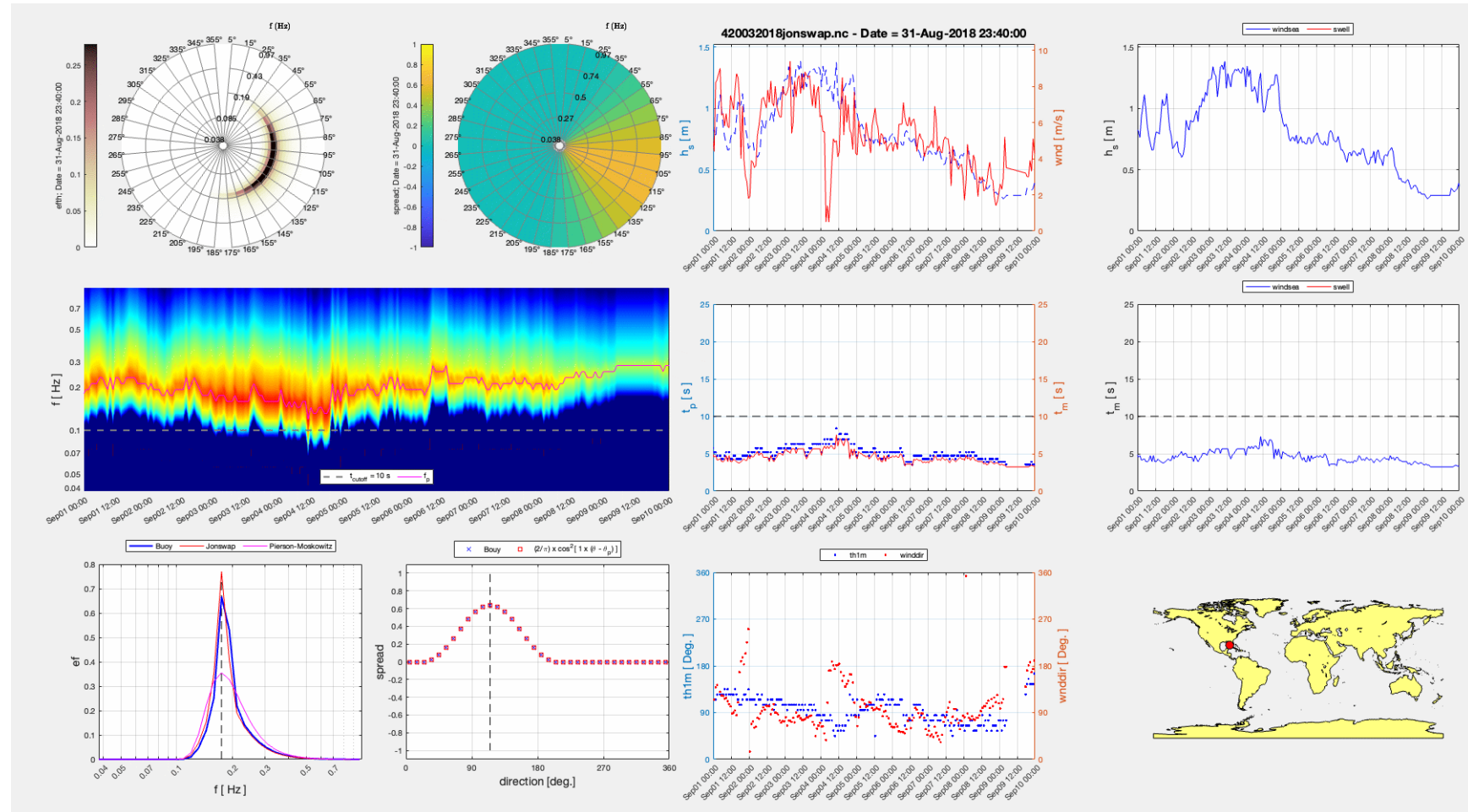
```
[SWDEN]= plot_wv3_spec(input_nc, ID, START, END, factor, dt, dtplot, visualize)
```



GENERATE BC FROM BULK STATS AT NDBC (JONSWAP)

```
input='42003h2018.nc'
```

```
factor=1
nfreq=35
nDir=36
inc=1.1
f0=0.038
method1='JONSWAP'
output1='420032018jonswap.nc'
coordinate='spherical'
START='20180901 000000'
END='20180910 000000'
dt=1/24
dtplot=1/2
visualize='true'
```



```
[SWDEN1]= stden_2_swden(input,output1,factor,nfreq,f0,inc,...
nDir,method1,coordinate,START,END,dt,dtplot,visualize);
```



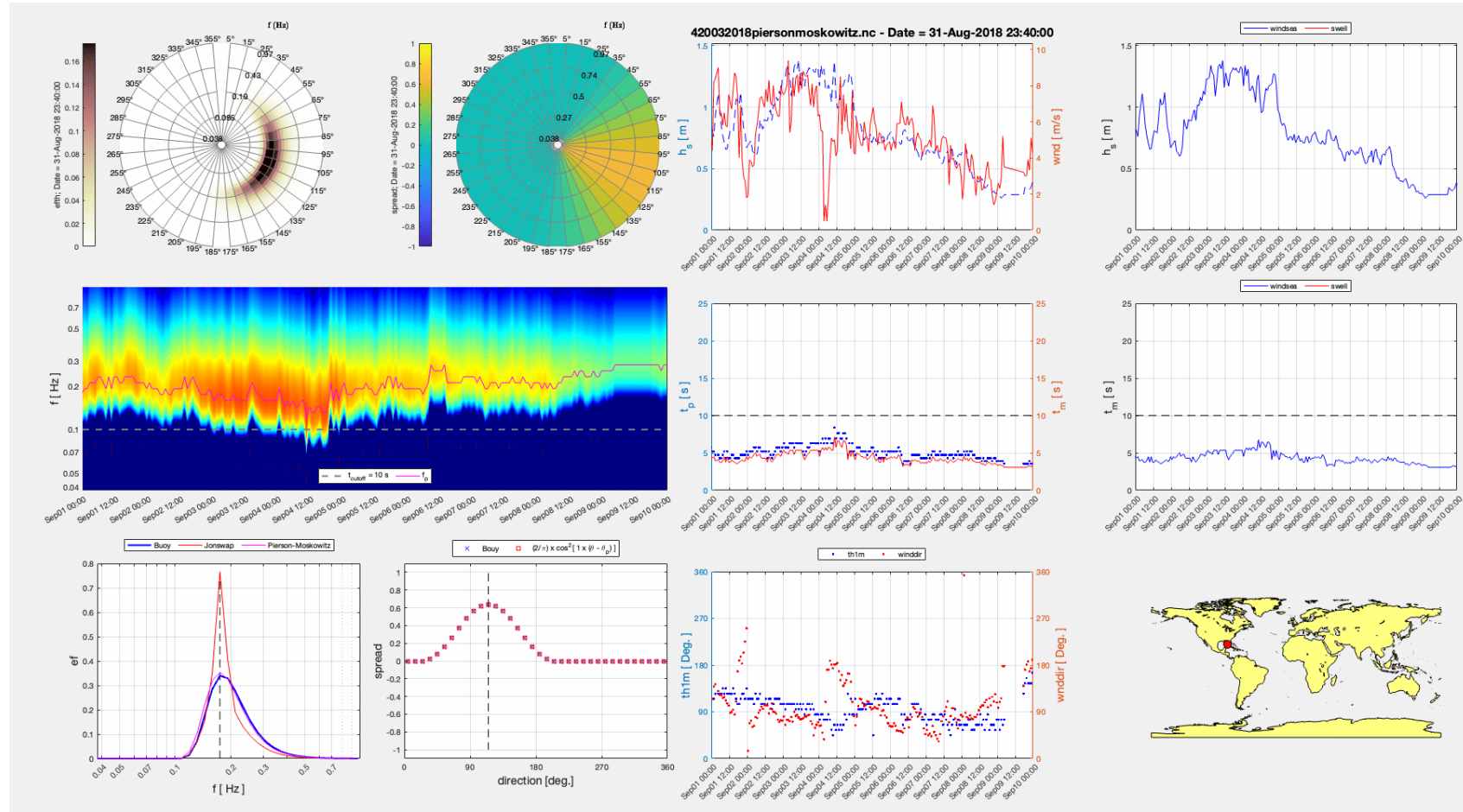

GENERATE BC FROM BULK STATS AT NDBC (PIERSON MOSKOWITZ)

input='42003h2018.nc'

```

factor=1
nfreq=35
nDir=36
inc=1.1
f0=0.038
method2='PIERSONMOSKOWITZ'
output2='420032018piersonmoskowitz.nc'
coordinate='spherical'
START='20180901 000000'
END='20180910 000000'
dt=1/24
dtplot=1/2
visualize='true'

```



```

[SWDEN2]= stden_2_swden(input,output2,factor,nfreq,f0,inc,...
nDir,method2,coordinate,START,END,dt,dtplot,visualize);

```